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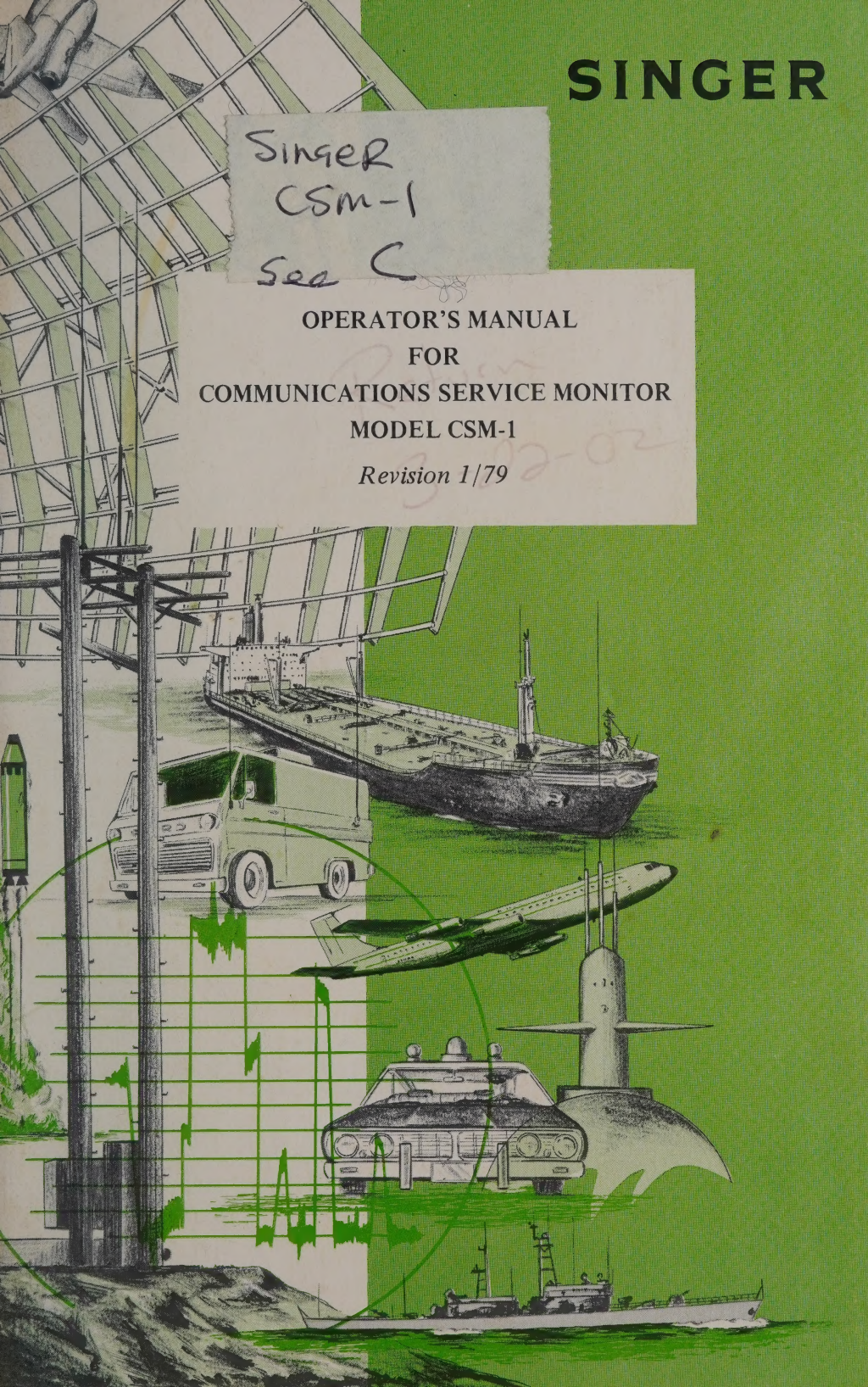
OPERATOR'S MANUAL
FOR
COMMUNICATIONS SERVICE MONITOR
MODEL CSM-1

Revision 1/79



OPERATOR'S MANUAL
FOR
COMMUNICATIONS SERVICE MONITOR
MODEL CSM-1

Manual No. 1-500783-311
(For use with serial numbers 101 and above)

For maintenance information, refer to Maintenance Manual
No. 1-500783-312

Revision 1/79

Contract Number:	DOT-FA75WA-3692
Contract Date:	June 30, 1975
Specification Number:	FAA-P-2596a

THE SINGER COMPANY
833 Sonora Avenue
Glendale, California 91201

FAPR 12A-7.160-3
Nov. 1974

WARRANTY

(a) Notwithstanding inspection and acceptance by the Government of supplies furnished under this contract or any provisions of this contract concerning the conclusiveness of said inspection and acceptance, the Contractor warrants each item delivered under the contract against defects in design, material or workmanship, and against any damage caused prior to delivery to the Government. Unless otherwise specified, this warranty extends for a period of one year from the date of first use by the Government or two years from date of delivery, whichever occurs first.

(b) Upon notice in writing, the Contractor shall, within 30 days after receipt of such notice repair or replace all defective or damaged items delivered under the contract, f.o.b. any point or points designated by the Government within the 48 contiguous states and the District of Columbia, at no cost to the Government. In the event the contractor is unable to effect such repair or replacement within the aforesaid 30 days, he shall within 15 days after receipt of notice, submit in writing a schedule of repair or replacement, to the Contracting Officer. The Contractor may elect to have any replaced item returned to his plant at his expense.

(c) Unless they fail as a result of improper application by the Contractor, electron tubes, batteries, natural rubber and material normally consumed in operation are excluded from this warranty, but shall in, any event be warranted by the Contractor to the extent of any warranty received by the Contractor from his supplier.

(d) If twenty percent (20%) or more of the total quantity of any part or component to which this warranty applies (but not fewer than two of any such part of component) fails in normal service, that fact shall be conclusive evidence that the design, material or workmanship of the item delivered under the contract is unsuitable for the purpose intended. Upon notice of this failure rate the Contractor shall: (i) replace all quantities of the part or component with a corrected part or component in a manner satisfactory to the Government, and at no cost to the Government, and (ii) if necessary to insure correction of the deficiency redesign the item delivered under the contract, or any portion thereof, in a manner satisfactory to the Government and at no cost to the Government. The provisions of this paragraph (d), however, shall not apply to any part or component to be furnished which is specifically identified in the contract by brand name; provided, however, that the Contractor shall warrant such part or component to the extent of any warranty received by the Contractor from his supplier.

(e) For a period of one year from the date of its first use by the Government or two years from the date of its replacement or redesign, whichever occurs first, each item (or portion thereof) or part or component, which is replaced or redesigned pursuant to paragraph (d) above, shall itself be warranted in accordance with the terms of paragraph (d).

(f) The warranty periods specified herein shall exclude any period of time an item fails to perform satisfactorily due to defects or damage to which this warranty applies.

(g) For the purposes of this "Warranty" clause, the term "item" is defined as the contact line item. In the event any item part, or subpart, or component thereof fails, the contractor shall be responsible for all actions necessary to correct such failure and return the contract line item to operating order.

(h) Failure to agree upon any determination to be made under this clause shall be a dispute concerning a question of fact within the meaning of the "Disputes" Clause of this contract.

SINGER INSTRUMENTATION
5340 Alla Road, Los Angeles, California 90066

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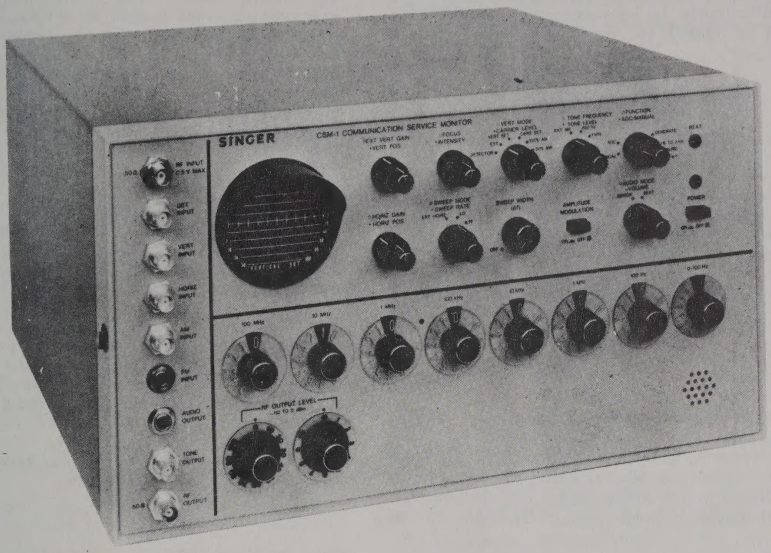


Figure 1-1. Communications Service Monitor, Model CSM-1

Section I

INTRODUCTION

1.1 SCOPE OF MANUAL

This manual is designed to provide information for the operation of the Communications Service Monitor, Model CSM-1. (See Figure 1-1). The manual is divided into five sections, containing an introduction; specifications; controls, indicators and receptacles; installation instructions; and operating instructions.

1.2 PURPOSE AND USE OF EQUIPMENT

The major capabilities of the Model CSM-1 may be described as the equivalent of three conventional instruments: an AM/CW signal generator, a frequency meter, and an amplitude modulation meter.

In addition, the Model CSM-1 provides other useful capabilities, such as a swept-frequency generator, a swept-frequency response curve display, a spectrum monitor, FM signal generator, a source of 400 Hz or 1 kHz audio tones and a general purpose oscilloscope.

1.2.1 Signal Generator Operation

As a signal generator, the Model CSM-1 provides CW, essentially free of spurious outputs, with 1 ppm direct synthesized frequency accuracy and stability, from 50 kHz to 512 MHz, with calibrated output levels in 1 dB steps from -110 dBm to 0 dBm (0.7 μV to 224 mV rms).

As an AM generator, amplitude modulation of up to 95%, as indicated on an integral CRT display, may be produced from an internal 400 Hz or 1 kHz source or from an external source.

As a sweep generator, a sweep width of up to 1 MHz may be achieved at repetition frequencies ranging from less than 10 Hz to greater than 100 Hz from an internal sawtooth generator.

As an FM generator, a peak deviation of up to 100 kHz and beyond, may be achieved with external modulating frequencies from less than 5 Hz up to greater than 3 kHz, or by the internal 400 Hz or 1 kHz source by means of a patch cable.

1.2.2 Frequency Meter Operation

As a frequency meter, the Model CSM-1 is capable of measuring the frequency of a received signal at a level as low as 2 μV, either via antenna or direct connection, at an accuracy of ±1 ppm (±0.0001%).

The frequency error between the received signal and the Model CSM-1 selected frequency is indicated by an audible beat tone for error frequencies less than 10 kHz and by a visual beat indicator (a light-emitting diode) for error frequencies less than 25 Hz, providing resolution within 1 Hz.

1.2.3 Amplitude Modulation Meter Operation

As an amplitude modulation meter, the Model CSM-1 is capable of measuring the percentage of amplitude modulation of received signals in two ranges: 0 to 30% and 0 to 100%, to within an accuracy of ±8% of full-scale deflection, with the recovered audio waveform displayed on a three-inch CRT. The percentage of amplitude modulation is indicated directly on a calibrated graticule.

1.2.4 Swept-Frequency Generator Operation

As a swept-frequency generator, the Model CSM-1 includes an internal saw-tooth generator, which provides a sweep width variable from 0 to greater than 1 MHz, and provides sweep rates variable from less than 10 Hz to greater than 100 Hz.

1.2.5 Spectrum Monitor Operation

As a spectrum monitor, the Model CSM-1 uses the combination of the internal swept-frequency capability and the AM measurement capability, to provide an amplitude versus frequency display on the CRT. A typical application is the monitoring of multi-channel activity in a communications band.

1.2.6 Audio Tone Generator Operation

As an audio tone generator, the Model CSM-1 provides a variable level 400 Hz or 1 kHz low distortion audio signal output for general purpose audio testing. In a typical application, the audio tone may be used to modulate a transmitter while simultaneously measuring amplitude modulation or frequency of the transmitter's output with the Model CSM-1.

1.2.7 Oscilloscope Operation

As an oscilloscope, the Model CSM-1 provides a 3-inch CRT display, vertical and horizontal controls, intensity and focus controls, provision for external vertical input from dc to greater than 30 kHz (3 dB bandwidth) and a choice of external horizontal input from 5 Hz to 30 kHz or an internal horizontal recurrent sweep at rates from 10 Hz to 5 kHz automatically synchronized to the vertical input signal.

1.3 GENERAL DESCRIPTION

The direct synthesizer method of frequency generation has been selected in the Model CSM-1 because of its superior overall stability and accuracy and its inherent calibration reliability. The direct synthesizer generates the selected output frequency by multiplying, dividing, adding, or subtracting several signals derived from a standard frequency 10 MHz temperature compensated crystal oscillator (TCXO) with a ±1 ppm accuracy.

The output frequency accuracy is therefore always equal to the accuracy of the standard frequency. Because there are no phase-locked loops with their inherent settling time, the desired output frequency is produced accurately at the instant that the frequency is selected (less than 1 millisecond). Since the fully synthesized mode produces only fixed frequencies, a variable frequency oscillator is also incorporated to provide continuous frequency coverage. The variable frequency oscillator in the Model CSM-1 operates in the megahertz range. However, its influence on the output frequency is selectable in five different ranges, depending upon which decade frequency switch is placed at the V position. This combination of a direct synthesizer and a variable oscillator provides a simple and fast method for measuring a transmitter frequency.

When the Model CSM-1 is used as a frequency meter, the unknown signal is received via the antenna or an input cable and heterodyned with the synthesized local oscillator (LO) frequency of the Model CSM-1 to provide a first intermediate frequency (IF) of 11 MHz which is further converted to 1 MHz and mixed with a 1 MHz synthesized frequency to produce an audio beat tone. By varying the frequency switches and 0 – 100 Hz control of the Model CSM-1, a zero beat will result when the two frequencies are exactly the same. The unknown signal frequency will then be indicated directly on the front panel frequency switches and the 0 – 100 Hz control. An automatic frequency offset system, located within the circuitry of the frequency switches, maintains the synthesized LO frequency 11 MHz above the indicated frequency of the measured signal.

The instrument is designed to operate from a power source of 120 V rms ±10% (108 V to 132 V rms) or 240 V rms ±10% (216 V to 264 V rms) at a frequency of 60 Hz ±3 Hz and consumes approximately 51 watts.

The side of the Model CSM-1 is equipped with a carrying handle located at the plane of the center of gravity. The back of the Model CSM-1 contains a power input receptacle that includes a fuse holder, 120 V or 240 V provisions, ac cord storage, and the power supply regulator heat sink.

A protective front cover is provided. Attached to the inside of the cover is a vinyl pouch which may be used to store accessories.

The outside cover for the Model CSM-1 is easily removed and presents the circuitry conveniently for service and adjustment. All circuits for the measurement and display functions are located on the upper part of the chassis corresponding to the front panel layout, and are located in a planar manner with all adjustments immediately available. Circuit components are labeled with their respective reference designations for efficient fault locating and servicing.

The attentuation of undesirable electromagnetic interference (EMI) and prevention of susceptibility to externally generated RF are achieved by containment (circuit design considerations including: adequate RF bypassing, shielding, shielded gasketing, and packaging).

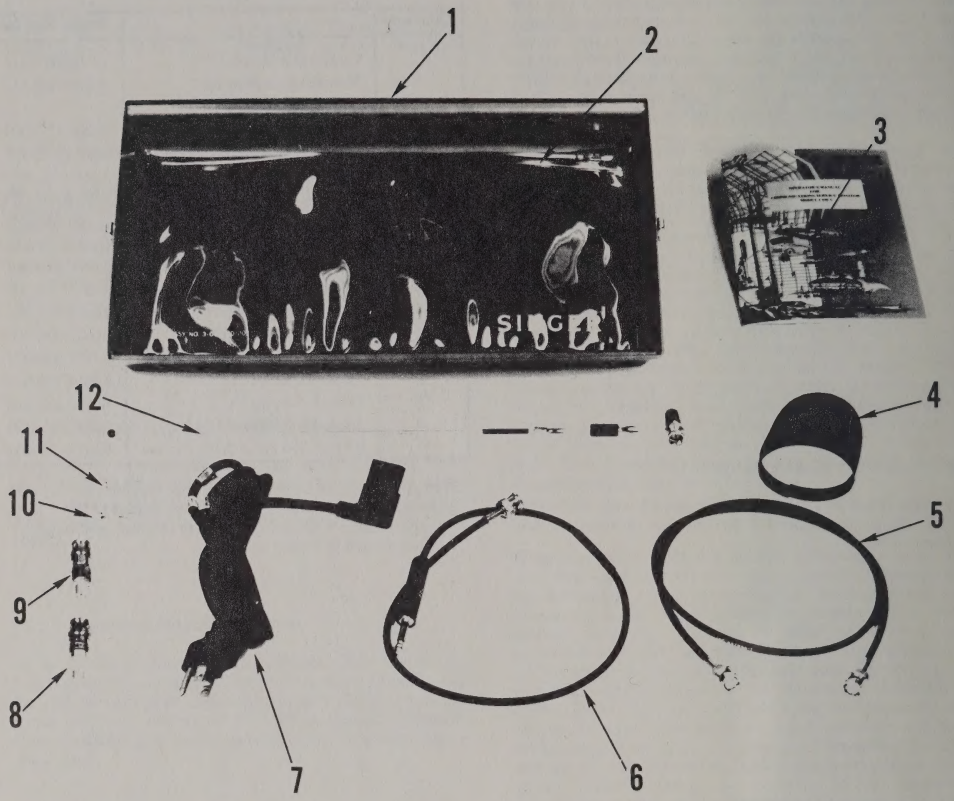
1.4 SUPPLIED ACCESSORIES

The items listed in Table 1-1 are furnished with the Model CSM-1. Refer to Figure 1-2 for display of some of the accessory items.

Table 1-1. Supplied Accessories

Quantity		Singer Part No.
2	Operator's Manual**†	1-500783-311
2	Maintenance Manual	1-500783-312
1	Antenna Assembly*†, consisting of:	2-005172-001
1	Adapter	1-910332-001
1	Adapter, Spade Lug	1-910333-001
1	Rod, Antenna	2-104044-001
1	Ball, Antenna	2-104046-001
1	Plug, Banana	1-910334-001
1	AC Power Cable, 7.5 Ft.†	1-910346-001
1	RF Cable, 3 Ft.*†	1-003159-001
1	Audio Cable, 2 Ft.*†	1-005367-001
1	Oscilloscope Hood†	3-103608-001
1	Protective Detachable Cover†	3-005300-001
1	Fuse, 1.0 amp.*†	1-924000-019
1	Fuse, 0.5 amp.*†	1-924000-014
1	RFA-20, RF Atten.*†	2-001355-001
1	RFF-2, RF Fuse Assy.*†	4-005430-002

* Normally stored in the zippered bag within the protective detachable cover, refer to Figure 1-2.
** One operator's manual is stored in the zippered bag.
† Items shown in Figure 1-2.



Item	Description	Item	Description
1	Protective Detachable Cover	7	AC Power Cable, 7.5 Ft.
2	Zippered Bag	8	RFA-20, RF Attenuator
3	Operator's Manual	9	RFF-2, RF Fuse Assembly
4	Oscilloscope Hood	10	Fuse, 0.5 Amp.
5	RF Cable, 3 Ft.	11	Fuse, 1.0 Amp.
6	Audio Cable, 2 Ft.	12	Antenna (Disassembled)

Figure 1-2. Model CSM-1 Accessories

Section II

SPECIFICATIONS

2.1 INTRODUCTION

This section of the manual contains specification information for the Model CSM-1. Specified parameters provided in the center column apply throughout the temperature range of 0°C to 50°C. Supplementary information located in the third column contains information such as a description of a feature, or limits or definitions of adjacent specified parameters in the second column.

2.2 SPECIFICATIONS

Tables 2-1 thru 2-4 contain specification data for the Model CSM-1.

Table 2-1. Specifications for the Generate Function

Characteristic	Specified Parameters	Supplementary Information
CW GENERATE FUNCTION		
Frequency	50 kHz to 512 MHz	
Range:		
Accuracy		
Synthesized mode:	1×10^{-6}	
Variable mode:	1×10^{-6} ± [(5 Hz at 25°C with temperature coefficient of 0.2 Hz/°C maximum) per 100 Hz of 0–100 Hz control range].	Refer to Table 5-1.
Resolution		
Synthesized mode:	100 Hz	from 50 kHz to 512 MHz.
Variable mode:	<1 Hz (1/2 division = 1 Hz).	0 to 100 Hz.
Stability		
Long term drift:	1×10^{-6}/yr. maximum.	Synthesized mode.
Medium term drift:	1×10^{-7}/mo. maximum.	
Residual FM:	25 Hz maximum.	Within a 3 kHz bandwidth.
Variable control range		(0–100 Hz control).
No frequency switch at V:		0 to 100 Hz
100 Hz switch at V:		0 to 1 kHz.
1 kHz switch at V:		0 to 10 kHz
10 kHz switch at V:		0 to 100 kHz.
100 kHz switch at V:		0 to 1 MHz.
Output Level		
Range:	-110 dBm to 0 dBm (0.7 μV to 224 mV rms).	
Accuracy:	±1 dB maximum	At -20 dBm at 250 MHz.
Flatness:	±1 dB over a 2:1 frequency range.	±2 dB maximum from 50 kHz to 512 MHz.
Attenuator		
Accuracy:		±2.0 dB referred to -20 dBm and from 50 kHz to 512 MHz.
Range:	110 dB total.	
100 dB step attenuator:	10 steps of 10 dB.	11 positions.
10 dB step attenuator:	10 steps of 1 dB.	11 positions.
Output Impedance:		
Output VSWR:	1.5:1 maximum.	50 ohms nominal
Output leakage:		Limited to allow receiver sensitivity measurement of 0.1 μV measured at a distance of 18 inches.

Table 2-1. Specifications for the Generate Function (Cont'd)

Characteristic	Specified Parameters	Supplementary Information
Spectral purity		
Harmonics:	At least 30 dB below carrier.	
Sub harmonics:	At least 50 dB below carrier.	
Non harmonics:	At least 50 dB below carrier.	
Close-in noise: (Noise Floor level test)	At least 65 dB below carrier in a 30 kHz bandwidth at a frequency of 200 kHz from the carrier.	As measured with a spectrum analyzer with 30 kHz bandwidth and 100 Hz video filter having noise floor 70 dBc minimum.
AM GENERATE FUNCTION		
AM indication:		CRT.
AM indication accuracy:	±8% of full-scale deflection.	
AM ranges:	0 to 30%, 3% max distortion.	(Internal and external at all output levels). 0 to 95%, 10% max distortion.
Incidental FM:	100 Hz +0.8 ppm maximum.	At 30% AM, ≤ 1 kHz mod. freq.
Internal modulating frequencies:	400 Hz ±5% or 1 kHz ±5%.	Selectable.
External modulating input		
Frequency range:	<50 Hz to >20 kHz.	±1 dB related to 1 kHz.
Impedance:	40 kilohm minimum.	
Sensitivity:	500 mV rms ±20%	for 30% AM.
FM GENERATE FUNCTION		
Peak deviation range:	0 to 100 kHz peak deviation	At 1% distortion (for modulating frequency <3 kHz).
Modulating frequency range:	<5 Hz to >3 kHz.	±3 dB related to 1 kHz.
Sensitivity:	100 mV rms ±10%	for 10 kHz peak deviation with 100 kHz switch at V position.
Input impedance:	600 ohms ±20%	
Carrier frequency accuracy:	$1 \times 10^{-6} \pm$ [(5 Hz at 25°C with temperature coefficient of 0.2 Hz/°C maximum) per 100 Hz of 0–100 Hz control range].	
AUDIO GENERATE FUNCTION		Available at TONE OUTPUT receptacle. May be connected by external accessory cable to FM INPUT receptacle to provide frequency modulation. (Refer to FM generate function).
Frequency:	400 Hz ±5% or 1 kHz ±5%.	

Table 2-1. Specifications for the Generate Function (Cont'd)

Characteristic	Specified Parameters	Supplementary Information
Output level:	2.5 Vrms minimum	Open-circuit voltage with the TONE LEVEL control at maximum cw position.
Output impedance:	600 ohms ±10%	
SWEEP GENERATE FUNCTION		
Sweep width range:	0 to 1 MHz minimum.	With 100 kHz switch at V position (500 kHz to 512 MHz).
Sweep repetition frequency:	<10 Hz to >100 Hz.	
SWEPT RESPONSE DISPLAY FUNCTION		
Swept display linearity:	1.5% typical non-symmetry.*	Over 20% of the 0–100 Hz control range.
Detector sensitivity:	300 mV rms typical.*	For full-scale deflection on the CRT graticule.
Detector input impedance:	600 ohms nominal.*	

Table 2-2. Specifications for Measure Function .

Characteristic	Specified Parameters	Supplementary Information
CW MEASURE FUNCTION		
Sensitivity:	2 μV or better.	Minimum signal level required for measurement.
Operate level range:	<2 μV to >20 mV rms.	
Maximum input level:	500 mV rms maximum	This level will not cause damage to the instrument.
Input impedance:	50 ohms nominal.	
Frequency error indication range:	<1 Hz to >10 kHz.	Via beat lamp and beat tone.
Frequency		
Range:	50 kHz to 512 MHz.	
Accuracy		
Synthesized mode:	1×10^{-6}.	
Variable mode:	1×10^{-6} ± [(5 Hz at 25°C with temperature coefficient of 0.2 Hz/°C maximum) per 100 Hz of 0–100 Hz control range].	Refer to Table 5-1.
Resolution		
Synthesized mode:	100 Hz.	50 kHz to 512 MHz.
Variable mode:	<1 Hz (1/2 division = 1 Hz).	0 to 100 Hz.

Table 2-2. Specifications for Measure Function (Cont'd)

Characteristics	Specified Parameters	Supplementary Information
Stability		
Long term drift:	1×10^{-6}/yr. maximum	
Medium term drift:	1×10^{-7}/mo. maximum.	
Residual FM:	25 Hz rms maximum.	Within a 3 kHz bandwidth.
Variable control range		(0–100 Hz control).
No frequency switch at V:		0–100 Hz.
100 Hz switch at V:		0 to 1 kHz.
1 kHz switch at V:		0 to 10 kHz.
10 kHz switch at V:		0 to 100 kHz.
100 kHz at V:		0 to 1 MHz.
Headphone receptacle voltage:	2 V rms minimum.	Into a 10 ohm load.
AM MEASURE FUNCTION		
AM ranges:	0 to 30%, 0 to 100%.	
AM frequency range:	<50 Hz to >3 kHz.	
AM indication		CRT
Accuracy:	±8% of full-scale deflection.	
Sensitivity:	2 μV rms.	Minimum signal level required for measurement.
Audio output level		
Power to speaker:	500 mW minimum.*	Into an 8 ohm load.
Headphone receptacle voltage:	2 V rms minimum.	Into a 10 ohm load.

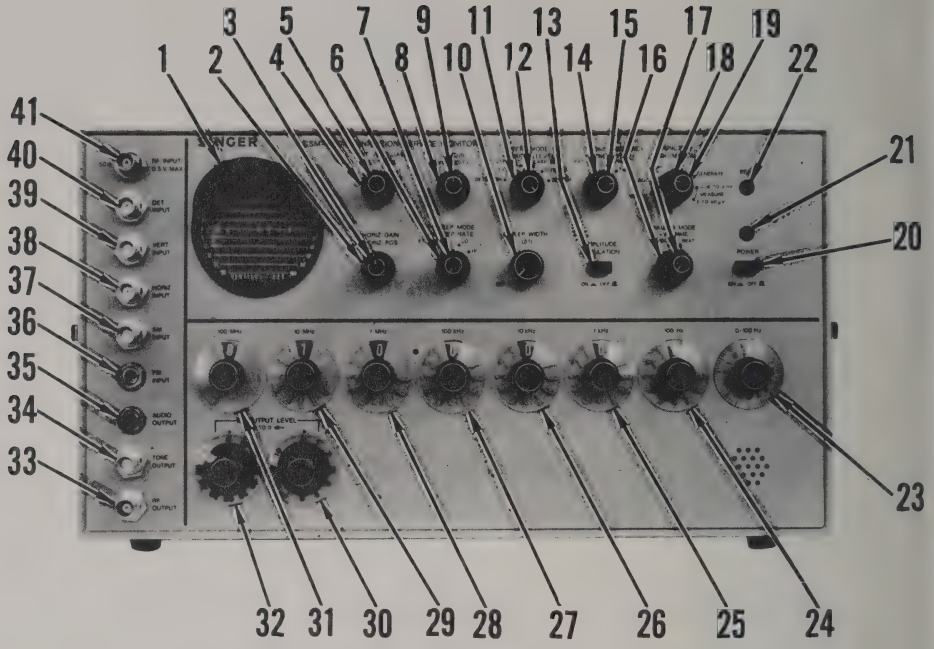
Table 2-3. Specifications for Oscilloscope Function

Characteristic	Specified Parameters	Supplementary Information
CRT size:		3" diameter nominal.
External vertical input		
Frequency response:	dc to >30 kHz.	3 dB down.
Sensitivity:	300 mV p-p ±10%	For full-scale deflection.
Impedance:	>70 kilohms	
Horizontal sweep		
Rate range:	<10 Hz to >5 kHz.	In two ranges.
Sweep type:		Recurrent.
Sync. type:		Automatic.
External horizontal input		
Frequency response:	<5 Hz to >30 kHz.	3 dB down.
Sensitivity	500 mV p-p maximum.	Per inch of deflection.
Impedance:	>500 kilohms.	

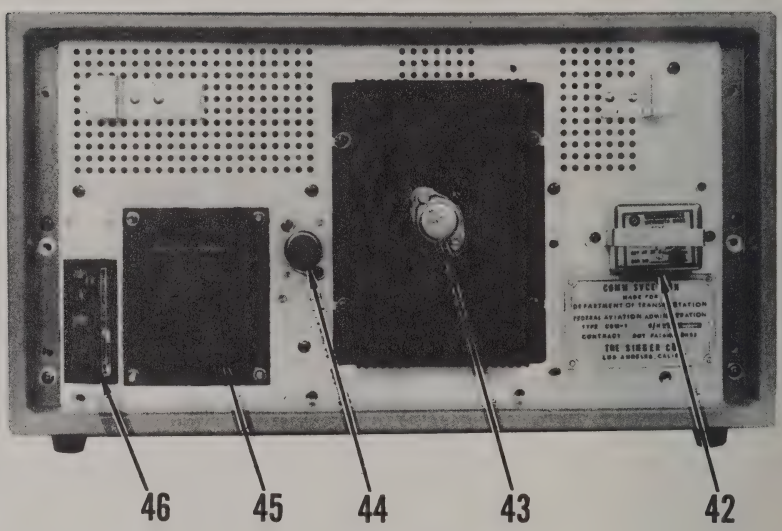
Table 2-4. Miscellaneous Specifications

Characteristics	Specified Parameters	Supplementary Information
Warm-up time:	10 s maximum.	
Switching time:	<1 ms.*	
Power requirements		
Operating voltage ranges:	108 V rms to 132 V rms.	And 216 V rms to 264 V rms.
Operating frequency:	57 Hz to 63 Hz.	
Power consumption:	75 W maximum.	51 W typical.
Operating temperature:	0 to +50°C (+32°F to +122°F).	
Altitude:	0 to 3048 m (0 to 10,000 ft).	Above mean sea level.
Relative humidity:	10% to 80%.	
Dimensions:		237 mm H, 427 mm W, 406 mm D (9.34 in H, 16.84 in W, 16.00 in D) (Less front cover).
Weight:		19.5 kg (43 lbs).
Paint:		FED-STD-595.
Front Panel:		Gray, No. 26440.
Case:		Textured blue No. 25189.

*Certain parameters are specified in section 2.2 that are not contractually required by the FAA. Nevertheless, they are included to more accurately characterize the performance of the unit. These supplementary specifications are indicated by an asterisk.



FRONT PANEL



BACK PANEL

Figure 3-1. Controls, Indicators, and Receptacles, Model CSM-1.

Section III

CONTROLS, INDICATORS, AND RECEPTACLES

.1 INTRODUCTION

he function of the controls, indicators, and receptacles of the Model CSM-1 are presented in this section of the manual. Refer to Table 3-1 and Figure 3-1. All items are located on the front and back panels of the instrument.

Table 3-1. Controls, Indicators, and Receptacles

Item	Panel Markings	Description	Function
1	AM % CARRIER SET VERTICAL SET	CRT (V1)	Provides the means of displaying the percentage of amplitude modulation of the incoming signal or is used to set up and monitor the percentage of AM in the AM generate mode.
2	HORIZ GAIN	Control (A17R3)	Provides the means for controlling the width of the CRT trace in both internal and external modes.
3	HORIZ POS	Control (A17R4)	Provides the means for controlling the horizontal position of the trace on the CRT screen.
4	EXT VERT GAIN	Control (A17R1)	Provides the means of controlling the displayed amplitude of the external signal applied to the VERT INPUT receptacle.
5	VERT POS	Control (A17R2)	Provides the means for controlling the vertical position of the trace on the CRT screen.
6	SWEEP MODE EXT HORIZ LO HI	3 position rotary switch (A18S1)	Provides the means for selecting the external sweep for the CRT or the internal sweep for both the CRT and the sweep generator functions in two ranges of sweep rate.
7	SWEEP RATE	Control (A18R3)	Provides the means for controlling the sweep rate from approximately 10 Hz to 5 kHz when used in conjunction with the SWEEP MODE switch.
8	FOCUS	Control (A18R1)	Provides the means for optimizing the focus of the electron beam on the CRT screen.
9	INTENSITY	Control (A18R2)	Provides the means for controlling the brightness of the CRT trace.
10	SWEEP WIDTH (Δ f) OFF	Control/ 2 position rotary switch (A19R1/A19S1)	Provides the means for controlling the swept frequency excursions above and below the center frequency and for switching the sweep off for normal fixed frequency operation.
11	VERT MODE DETECTOR EXT VERT SET CARR SET 100% AM 30% AM	6 position rotary switch (A19S2)	Provides the means for selecting the inputs to the vertical deflection system of the CRT. The inputs available are as follows: the internal detector which receives signals from the DET INPUT receptacle, the VERT INPUT receptacle, and the modulating audio signal in two ranges: 100% AM, and 30% AM. Two positions VERT SET and CARR SET provide the means for calibrating the modulation display.

Table 3-1. Controls, Indicators, and Receptacles (Cont'd)

Item	Panel Markings	Description	Function
12	CARRIER LEVEL	Control (A19R2)	Provides the means for calibrating the amplitude modulation display when the VERT MODE switch is set at the CARR SET position. Also provides manual control of the sensitivity in the MANUAL mode for the MEASURE function.
13	AMPLITUDE MODULATION ON ▬ OFF ▙	Push-push switch (A20S2)	Provides the means for internally disconnecting the internal AM or the external AM for rapid comparison of the modulated and unmodulated signal, when Item 18 is in the GENERATE mode.
14	TONE FREQUENCY EXT AM 400 Hz 1 kHz	3 position rotary switch (A20S1)	Provides the means for selecting either the internal 400 Hz or 1 kHz modulating signal, or the external modulating signal applied to the AM INPUT receptacle. Also selects the tone frequency (400 Hz or 1 kHz) available at the TONE OUTPUT receptable, Item 34.
15	TONE LEVEL	Control (A20R1)	Provides the means for controlling the level of generated amplitude modulation in both internal and external modes, and provides the means for controlling the level of the 400 Hz or 1 kHz audio signal at the TONE OUTPUT receptacle.
16	AUDIO MODE DEMOD BEAT	2 position rotary switch (A21S2)	Provides the means for selecting the source of the input to the audio circuitry. Either the recovered audio from the demodulated input signal may be selected or the beat tone difference between the unknown input signal and the frequency selected on the Model CSM-1 front panel.
17	VOLUME	Control (A21R1)	Provides the means for controlling the level of the audio from the internal speaker or a remote speaker or headphones, when Item 18 is in the MEASURE mode.
18	FUNCTION GENERATE MEASURE 0.06 to 2 mV 2 to 60 μV	3 position rotary switch (A21S1)	Provides the means for selecting either the generate mode or the measure mode, and the measure sensitivity.
19	AGC/MANUAL AGC MANUAL	2 position rotary switch (A21S3)	Provides the means for selecting the AGC mode to minimize the effects of signal variations (such as in AM measurements off the air) or the MANUAL mode for constant sensitivity (such as in spectrum monitor use).
20	POWER ON ▬ OFF ▙	Push-push switch (S1)	Provides the means for energizing the Model CSM-1.
21	POWER	Green indicator (CR2)	Provides the means for indicating when the Model CSM-1 is energized.
22	BEAT	Red indicator (CR3)	Provides the means for displaying the error signal in the measure mode of operation. (Flashes at the rate of the frequency of the error signal.)

Table 3-1. Controls, Indicators, and Receptacles (Cont'd)

Item	Panel Markings	Description	Function
23	0 – 100 Hz OUT – 0-1-2-3-4-5 -6-7-8-9-10	Control/ 2 position rotary switch (A16R1/A16S1)	Provides the means for varying the frequency continuously in five ranges of increments: 0 to 100 Hz (no frequency switch at V position). 0 to 1 kHz (100 Hz switch at V position). 0 to 10 kHz (1 kHz switch at V position). 0 to 100 kHz (10 kHz switch at V position). 0 to 1 MHz (100 kHz switch at V position).
24	100 Hz 0-1-2-3-4-5- 6-7-8-9-V	11 position rotary switch (A15S1)	Provides the means for changing the frequency in 100 Hz steps. The V position switches the 0–100 Hz control into the circuit, providing a continuously variable increment from 0 to 1 kHz.
25	1 kHz 0-1-2-3-4-5- 6-7-8-9-V	11 position rotary switch (A14S1)	Provides the means for changing the frequency in 1 kHz steps. The V position switches the 0–100 Hz control into the circuit, providing a continuously variable increment from 0 to 10 kHz.
26	10 kHz 0-1-2-3-4-5- 6-7-8-9-V	11 position rotary switch (A13S1)	Provides the means for changing the frequency in 10 kHz steps. The V position switches the 0–100 Hz control into the circuit, providing a continuously variable increment from 0 to 100 kHz.
27	100 kHz 0-1-2-3-4-5- 6-7-8-9-V	11 position rotary switch (A12S1)	Provides the means for changing the frequency in 100 kHz steps. The V position switches the 0–100 Hz control into the circuit, providing a continuously variable increment from 0 to 1 MHz.
28	1 MHz 0-1-2-3-4-5 -6-7-8-9	10 position rotary switch (A11S1)	Provides the means for changing the frequency in 1 MHz steps.
29	10 MHz 0-1-2-3-4-5- 6-7-8-9	10 position rotary switch (A9S2)	Provides the means for changing the frequency in 10 MHz steps
30	RF OUTPUT LEVEL -110 to 0 dBm 0-1-2-3-4-5- 6-7-8-9-10	11 position rotary switch (AT2)	Provides the means for changing the RF output level in 1 dB steps.
31	100 MHz 0-1-2-3-4-5	6 position rotary switch (A10S1)	Provides the means for changing the frequency in 100 MHz steps.
32	RF OUTPUT LEVEL -110 to 0 dBm 0-10-20-30-40-50- 60-70-80-90-100	11 position rotary switch (AT1)	Provides the means for changing the RF output level 10 dB steps.
33	RF OUTPUT 50 Ω	BNC receptacle (J2)	Provides the means for connecting the RF output to external equipment.

Table 3-1. Controls, Indicators, and Receptacles (Cont'd)

Item	Panel Markings	Description	Function
34	TONE OUTPUT	BNC receptacle (J9)	Provides the means for connecting the internal 400 Hz or 1 kHz audio tone to external equipment for audio testing or may be used for FM generation when connected to the FM INPUT receptacle.
35	AUDIO OUTPUT	Phone jack (J3)	Provides the means for connecting a speaker or headphones to monitor the recovered audio remotely.
36	FM INPUT	Phone jack (J4)	Provides the means for externally frequency modulating the Model CSM-1.
37	AM INPUT	BNC receptacle (J5)	Provides the means for externally amplitude modulating the Model CSM-1.
38	HORIZ INPUT	BNC receptacle (J6)	Provides the means for external horizontal drive when the CRT is used as a general-purpose oscilloscope.
39	VERT INPUT	BNC receptacle (J7)	Provides the means for external vertical drive when the CRT is used as a general-purpose oscilloscope.
40	DET INPUT	BNC receptacle (J8)	Provides the means for connecting the internal RF detector to the device under test so that the detector output may be displayed on the CRT when the VERT mode switch is at the DETECTOR position.
41	RF INPUT 0.5 V MAX 50 Ω	BNC receptacle (J10)	Provides the means for connecting the signal to be measured to the Model CSM-1.
42		TXCO (Y1)	Temperature compensated crystal oscillator from which all fixed frequencies are derived.
43		Power transistor (Q1)	+9 V dc power supply regulator transistor.
44		Power supply regulator (U1)	+5 V dc power supply regulator.
45		Power transformer (T1)	Power transformer for Model CSM-1.
46	120/240 V rms ±10% 60 Hz ±5% 120 V ac 1.0 AMP SLOW BLOW FUSE 240 V ac 0.5 AMP SLOW BLOW FUSE	3 pin receptacle (J1)	Provides the means for applying primary power to the instrument, changing the fuse, and converting between 120 V and 240 V rms operation.

Section IV

INSTALLATION INSTRUCTIONS

4.1 INTRODUCTION

This section of the manual contains instructions on preparing the instrument for operation.

4.2 EQUIPMENT SETUP

a. Place the Model CSM-1 on any convenient flat surface.

b. Remove the protective cover from the instrument panel. A zippered bag within the protective cover normally contains the following accessory items:

Antenna Assembly (3 separable parts)

RF Cable, 3 Ft.

Audio Cable, 2 Ft.

Spare Fuse, 1.0 Amp., Slow Blowing (for 120 V operation)

Spare Fuse, 0.5 Amp., Slow Blowing (for 240 V operation)

RF Attenuator, Model RFA-20

RF Fuse Assembly, 1/8 Amp., Model RFF-2

Two operator's manuals

c. The Model CSM-1 is shipped ready to operate on 108 V rms to 132 V rms, 57 Hz to 63 Hz. For 216 V rms to 264 V rms operation refer to Paragraph 4.3. Unwind the ac power cable from the clips on the back panel and plug into 120 V ac, 3-pin grounded mains supply.

d. Push the POWER switch to ON position. Illumination of the adjacent green lamp indicates that the Model CSM-1 equipment is ready for immediate use. The CRT heater requires about 15 seconds warmup time. If the CRT is not required, the trace may be inhibited by turning the BRIGHTNESS control fully counterclockwise.

e. The antenna attaches to the RF INPUT receptacle in a vertical position when in use. The antenna consists of three separable pieces. All three pieces are required for vertical positioning when the Model CSM-1 is resting on its feet on a horizontal surface. Loosen the binding post to adjust antenna position, then tighten. Two pieces are required for vertical mounting when the Model CSM-1 front panel is in a horizontal position. The assembled antenna may be stored in the bag.

f. The 3-foot RF cable may be used when connecting the RF OUTPUT or RF INPUT receptacle to equipment under test. Do not connect to a source of power.

CAUTION

Whenever the Model CSM-1 is connected to a transmitter-receiver, prevent accidental keying to avoid internal damage in the Model CSM-1. Use the Model RFF-2 RF Fuse Assembly at the RF INPUT or RF OUTPUT receptacle as a precaution.

g. The Model RFF-2 RF fuse assembly should be used at the RF INPUT and at the RF OUTPUT receptacle to protect the Model CSM-1 whenever presence of external voltages in excess of 0.5 V are possible.

h. The Model RFA-20 attenuator is used for sensitive receiver measurements where signal levels required are less than the minimum available from the Model CSM-1 RF OUTPUT. The attenuator is also used at the end of 50 ohm RF cable connected to the Model CSM-1 RF OUTPUT when the load has poor input VSWR or is other than 50 ohms.

4.3 240 V OPERATION

a. Remove the line cord from the receptacle on the back panel of the Model CSM-1.

b. Slide the transparent fuse cover to downward to expose the fuse.

c. Pull the FUSE PULL lever out and downward to release the fuse.

d. Remove the fuse.

e. With the FUSE PULL lever completely down, remove the printed circuit card by means of the hole in the end of the card.

f. Turn the printed circuit card over to expose the number 240 and re-insert.

g. Set the FUSE PULL lever completely downward and replace the fuse with 0.5 A slow blowing for 240 V rms operation.

h. Slide the transparent fuse cover upward.

i. Replace the line cord into the receptacle.

4.4 RF FUSE REPLACEMENT

Use the following procedure when replacing the fuse in the Model RFF-2 RF Fuse Assembly:

a. Verify failure of fuse by testing for continuity through the fuse assembly. If open-circuited, proceed to Step b.

b. To replace the fuse element, first loosen and remove the BNC female connector fittings using two open end wrenches with 7/16 inch openings.

c. After the BNC female fitting has been removed, the fuse element will be available for removal from either portion of the fuse assembly, see Figure 4-1. Remove the fuse element by hand or with pliers.

d. Insert a new fuse element and reassemble, using the reverse procedure. Be sure the fuse element leads are in line, symmetrical with the body, and are of the proper length, see Figure 4-2.

NOTE

Make RF Fuse Element from Singer P/N 1-924011-002 (Little Fuse No. 275.125).

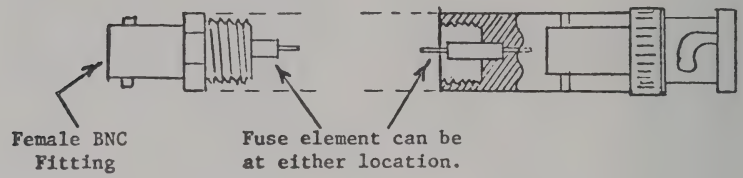


Figure 4-1. RF Fuse Disassembly

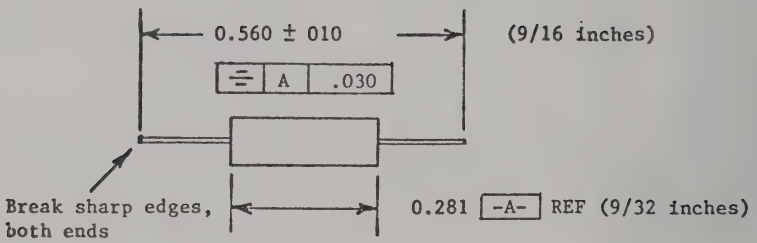


Figure 4-2. RF Fuse Element Details

Section V

OPERATING INSTRUCTIONS

5.1 INTRODUCTION

Instructions for operating the Model CSM-1 are presented in this section of the manual. Operation of the Model CSM-1 is extremely simple and does not involve calibration or phase-locking procedures. Any desired frequency is obtained immediately with fully-rated accuracy when the power is switched on and the frequency switches are set to the desired value.

5.2 GENERATE MODE

CAUTION

Whenever the RF OUTPUT receptacle of the Model CSM-1 is connected to the antenna of a transmitter-receiver, prevent accidental keying as this will destroy the 100 dB step attenuator in the Model CSM-1. Use the Model RFF-2 RF Fuse Assembly at the RF OUTPUT receptacle as a precaution.

5.2.1 CW Frequency Generation

a. Set the Model CSM-1 controls and switches as follows:

FUNCTION	GENERATE
AMPLITUDE MODULATION	OFF
SWEEP WIDTH (Δ f)	OFF
POWER	ON

b. Set the frequency switches and 0-100 Hz control to the desired frequency.

c. Set the RF OUTPUT LEVEL switches to the desired output level. (Refer to Table 5-3 for conversion from dBm to volts).

d. The desired signal frequency and output level will be available at the RF OUTPUT receptacle.

5.2.2 Manually-Swept Frequency Generation

a. Set the Model CSM-1 as described in Paragraph 5.2.1.

b. To manually sweep 1 MHz:

Set the 100 kHz switch to V. Set the frequency switches to the left of the 100 kHz switch to select the low end of the sweep frequency range. Rotate the 0-100 Hz control through its range to manually sweep over a 1 MHz range starting at the selected frequency.

c. To manually sweep 100 kHz:

Set the 10 kHz switch to V. Set the frequency switches to the left of the 10 kHz switch to select the low end of the sweep frequency range. Rotate the 0-100 Hz control through its range to manually sweep over a 100 kHz range starting at the selected frequency.

d. To manually sweep 10 kHz:

Set the 1 kHz switch to V. Set the frequency switches to the left of the 1 kHz switch to select the low end of the sweep frequency range. Rotate the 0-100 Hz control through its range to manually sweep over a 10 kHz range starting at the selected frequency.

e. To manually sweep 1 kHz:

Set the 100 Hz switch to V. Set the frequency switches to the left of the 100 Hz switch to select the low end of the sweep frequency range. Rotate the 0-100 Hz control through its range to manually sweep over a 1 kHz range starting at the selected frequency.

f. To manually sweep 100 Hz:

Set all seven frequency switches to select the low end of the sweep frequency range (no switches in the V position). Rotate the 0-100 Hz control through its range to manually sweep over a 100 Hz range starting at the selected frequency.

5.2.3 Internally-Swept Frequency Generation and Display

a. Set the Model CSM-1 controls and switches as follows:

FUNCTION	GENERATE
VERT MODE	DETECTOR
SWEEP WIDTH (Δ f)	Fully clockwise
AMPLITUDE MODULATION	OFF
POWER	ON

b. Vary the VERT POS, FOCUS, INTENSITY, HORIZ POS, and HORIZ GAIN controls to produce a trace on the VERTICAL SET line on the CRT graticule and for full-scale deflection in the horizontal axis.

c. Connect the input of the device to be swept to the RF OUTPUT receptacle.

d. Connect the output of the device to be swept to the DET INPUT receptacle.

NOTE

A level of approximately 300 mV rms is required at the DET INPUT receptacle for full-scale deflection (10 divisions). The loading effect of the 600 ohm nominal input impedance of the detector must be considered when connecting to the output of the device under test. (The loading will be minimal on 50 Ω circuits but will drastically affect high impedance circuits.)

e. Set the Model CSM-1 switches and controls to generate an unmodulated signal as in Paragraph 5.2.1.

f. Select the center frequency and sweep range by referring to Table 5-1 and setting the appropriate frequency switch to the V position. (If more than one switch is set to the V position, only the highest one is effective.)

Table 5-1. Sweep Ranges

Frequency Switch at V position	Frequency Range of 0-100 Hz Control	Sweep Width Capability
None	0 to 100 Hz	>100 Hz
100 Hz	0 to 1 kHz	>1 kHz
1 kHz	0 to 10 kHz	>10 kHz
10 kHz	0 to 100 kHz	>100 kHz
100 kHz	0 to 1 MHz	>1 MHz

g. Set the SWEEP MODE switch to the LO position and set the SWEEP RATE control for the desired sweep rate. Use lowest rate to eliminate resolution distortion. Increase rate to eliminate flicker.

h. Set the SWEEP WIDTH (Δ f) control for the desired frequency excursions.

i. Vary the RF OUTPUT LEVEL switches to obtain the desired display amplitude (normally 10 divisions with the peak of the response curve 10 divisions up from the VERTICAL SET graticule line).

NOTE

In interpreting the swept-frequency response display, there will be some vertical amplitude non-linearity in the form of compression near the base line, a characteristic of the diode detector, as the operating level varies between the linear region (high level) and the square-law region (low level). Typically -6 dB will appear as 46% of full-scale deflection on the graticule and -20 dB will appear as 4%.

After obtaining a swept-frequency response display, the frequency at the peak of the displayed curve may be measured as follows:

j. Set the SWEEP WIDTH (Δ f) control to the OFF position to disable the sweep. The Model CSM-1 will be in the manual search mode with the CRT serving as a dc voltmeter.

k. Shift the frequency up and down using the 0-100 Hz control while observing the trace position. When it is at its highest position (which should correspond to the graticule position previously observed at the peak of the curve) the frequency switches and 0-100 Hz control will indicate the frequency of the peak response. For greater resolution, repeat Step k with no frequency switches at the V position.

NOTE

Other points of interest on the displayed curve may be measured using a similar technique; for example, the 6 dB bandwidth points may be measured as follows:

l. Increase the generator level by 6 dB. The beam should deflect farther upward.

m. Increase the frequency using the frequency switches and the 0-100 Hz control until the beam returns to the point on the graticule previously noted at the peak. The frequency switches and 0-100 Hz control will indicate the upper frequency -6 dB point.

n. Decrease the frequency for a similar readout of the lower frequency -6 dB point.

5.2.4 Internally-Modulated AM Signal Generation

a. Set the Model CSM-1 frequency switches and the 0-100 Hz control to the desired carrier frequency.

b. Set the switches and controls as follows:

FUNCTION	GENERATE
SWEEP WIDTH (Δ f)	OFF
AMPLITUDE MODULATION	ON
VERT MODE	VERT SET
TONE FREQUENCY	400 Hz or 1 kHz
POWER	ON

c. Vary the VERT POS, FOCUS, INTENSITY, HORIZ POS, and HORIZ GAIN controls to produce a trace on the VERTICAL SET line of the CRT graticule and for full-scale deflection in the horizontal axis.

d. Set the VERT MODE switch to the CARR SET position. .

e. Vary the CARRIER LEVEL control to position the trace on the CARRIER SET line of the graticule.

f. Set the VERT MODE switch to either 30% AM or 100% AM, as desired.

g. Vary the TONE LEVEL control for the desired percentage of modulation as indicated on the CRT graticule. Use the LO or HI positions of the SWEEP MODE switch and vary the SWEEP RATE control to synchronize the display.

5.2.5 Externally-Modulated AM Signal Generation

a. Connect the external modulating source to the AM INPUT receptacle.

NOTE

0.6 V rms is required for 30% modulation with the TONE LEVEL control at maximum cw. Frequency response is < 50 Hz to >20 kHz.

b. Set the frequency switches and 0-100 Hz control to the desired carrier frequency.

c. Set the switches and controls as follows:

FUNCTION	GENERATE
SWEEP WIDTH (Δ f)	OFF
AMPLITUDE MODULATION	ON
VERT MODE	VERT SET
TONE FREQUENCY	EXT AM
POWER	ON

d. Vary the VERT POS, FOCUS, INTENSITY, HORIZ POS, and HORIZ GAIN controls to produce a trace on the VERTICAL SET line of the CRT graticule and for full-scale deflection in the horizontal axis.

e. Set the VERT MODE switch to the CARR SET position.

f. Vary the CARRIER LEVEL control to position the trace on the CARRIER SET line of the graticule.

g. Set the VERT MODE switch to the 30% AM or 100% AM position.

h. Set the TONE LEVEL control the desired percentage of modulation as indicated on the CRT. Use the LO or HI positions of the SWEEP MODE switch and vary the SWEEP RATE control to synchronize the display.

5.2.6 Externally-Modulated FM Signal Generation

a. Connect an external modulating source to the FM INPUT receptacle.

NOTE

100 mV rms ±10% is required for 10 kHz peak deviation with the 100 kHz switch at the V position. Peak deviations up to 100 kHz and beyond are possible. The modulating frequency range is <5 Hz to >3 kHz. If desired, the 400 Hz or 1 kHz internal modulating source may be used as described in Steps e thru h below:

b. Set the switches and controls as follows:

FUNCTION	GENERATE
SWEEP WIDTH (Δ f)	OFF
AMPLITUDE MODULATION	OFF
POWER	ON

c. Set the carrier frequency and deviation range by referring to Table 5-2 and setting appropriate frequency switch to the V position. Refer to Paragraph 5.2.2 for explanation of the function of the V position of the frequency switches.

d. Set the peak deviation by varying the level of the external modulating signal. The peak deviation is 10.0 kHz ±10% per 100 mV rms of input level with the 100 kHz switch at the V position.

Table 5-2. Peak Deviation and 0-100 Hz Control Ranges

Frequency Switch at V Position	Peak Deviation Capability	0-100 Hz Control Range
None	10 Hz	100 Hz
100 Hz	100 Hz	1 kHz
1 kHz	1 kHz	10 kHz
10 kHz	10 kHz	100 kHz
100 kHz	100 kHz	1 MHz

NOTE

The above Peak Deviation Capability column indicates typical performance with less than 1% distortion. Peak deviation capability typically 4 to 5 times the values indicated may be obtained with 3% distortion.

e. The internal 400 Hz or 1 kHz modulating source may be used by connecting the TONE OUTPUT receptacle to the FM INPUT receptacle using the accessory audio cable provided.

f. Set the switches and controls as follows:

FUNCTION	GENERATE
SWEEP WIDTH (Δ f)	OFF
AMPLITUDE MODULATION	OFF
TONE FREQUENCY	400 Hz or 1 kHz, as desired
POWER	ON

g. Set the carrier frequency and deviation range by referring to Table 5-2 and setting the appropriate frequency switch to the V position. Refer to Paragraph 5.2.2 for explanation of the function of the V position of the frequency switches.

h. Vary the TONE LEVEL control for the desired peak deviation. The peak deviation is 10 kHz ±10% per 100 mV rms of input level with the 100 kHz switch at the V position. The voltage level may be monitored with an ac voltmeter, using a T adapter.

5.2.7 Audio Test Tone Generation

Either 400 Hz or 1 kHz is available at the TONE OUTPUT receptacle whenever the TONE FREQUENCY switch is set to either the 400 Hz or 1 kHz position.

The level may be varied by means of the TONE LEVEL control up to at least 2.5 V rms, open circuit.

The output impedance is 600 ohms ±20%.

5.3 MEASURE MODE

5.3.1 Signal Level Requirements

a. The specified operate range is 2 μV to 2 mV rms.

b. For AM measurements, the input signal level must be within the specified operate range to permit "carrier set" level on the CRT.

Excessive input signal level is indicated by the inability to lower the CRT trace position to the CARRIER SET line of the graticule with the CARRIER LEVEL control.

c. Frequency measurements may be performed with signal levels ranging from less than 2 μV to beyond 20 mV.

Stronger signals up to the maximum input level limit of 500 mV will provide a suitable beat indication; however, these very high signal levels may produce spurious responses due to mixer overload. Therefore, if the unknown signal frequency is not known to within approximately ±10 kHz, attenuate the signal level to within the specified operate range before performing a wideband frequency search procedure, to avoid tuning to a spurious response frequency.

NOTE

Frequency measurements may be performed on fully-modulated AM signals; however, on FM signals, the beat indications may be obscured by peak deviations in excess of approximately 500 Hz.

CAUTION

Avoid application of transmitter power directly to the RF INPUT receptacle as this will cause internal damage to the instrument. Use the Model RFF-2 RF Fuse Assembly at the RF INPUT as a precaution.

5.3.2 Signal Coupling

a. For off-the-air measurements, connect the antenna provided to the RF INPUT receptacle.

b. For direct connection from a transmitter, connect as in Figure 5-1, using a directional coupler or other thruline sampler with the thruline section connecting the transmitter output directly to the RF load, and the attenuated output connected to the RF INPUT receptacle through the Model RFF-2 RF fuse. An auxiliary attenuator should be added if necessary to lower the input signal level to within the specified operate range (Refer to Paragraph 5.3.1).

Example:

10 watt transmitter	+40 dBm (22.3V)
RF INPUT level	-47 dBm (1.0 mV)
Total attenuation required	87 dB
Sampling attenuator	40 dB
Auxiliary attenuator required	47 dB

CAUTION

The sampling attenuator input must be rated to withstand the power level of the transmitter under test, which is capable of destroying small signal attenuators such as the Singer Model RFA-20. The RFA-20 can dissipate 1/4 watt (3.5 V) maximum. Avoid application of transmitter power directly to the RF INPUT receptacle as this will cause internal damage to the instrument. Use the Model RFF-2 RF Fuse Assembly at the RF INPUT as a precaution.

5.3.3 Operating Notes

a. The measure input circuitry of this instrument contains a wideband amplifier, followed by a high level, doubly-balanced mixer with no preselection. This minimizes cross-modulation from strong interfering signals, and allows high sensitivity across the entire operating range of the Model CSM-1.

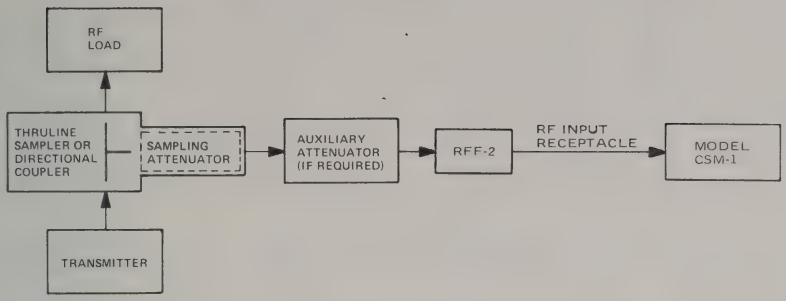


Figure 5-1. Direct Connection, Measuring Mode

b. Image interference may occur from signals 22 MHz above the desired frequency. This can be eliminated when the desired signal is above 22 MHz by setting the frequency switches of the Model CSM-1 to exactly 22 MHz lower than the desired signal frequency to place the synthesized local oscillator frequency 11 MHz below instead of above the desired frequency.

c. For remote presentation of the beat note, connect a speaker or headphone to the AUDIO OUTPUT receptacle. The internal speaker is disconnected when an external device is connected to the AUDIO OUTPUT receptacle.

.3.4 CW Frequency Measurement and Manual Search Mode

a. Set the controls and switches as follows:

SWEEP WIDTH (Δ f)	OFF
AUDIO MODE	BEAT
VOLUME	Maximum cw
AGC/MANUAL	AGC
POWER	ON

b. Couple the signal to be measured to the RF INPUT receptacle either directly or by means of the provided antenna.

c. Set the frequency switches to the transmitter frequency, if known, and set the FUNCTION switch to "MEASURE 2 to 60 μV" for low level signals or "MEASURE 0.06 to 2 mV" for high level signals.

d. Vary the frequency switches and 0–100 Hz control for a zero beat indication from the speaker, varying the VOLUME control as necessary. As the zero beat is approached, the BEAT indicator will flash at the error frequency. Continue varying the frequency switches and 0–100 Hz control to the minimum flashing rate. The frequency switches and 0–100 Hz control will indicate the frequency of the transmitter.

Example: 152.473821 MHz

i Set the frequency switches to 152 MHz and the 100 kHz switch to V.

ii Vary the 0–100 Hz control for zero beat and note the 0–100 Hz control frequency indication. (Example 4.7)

iii Set the 100 kHz switch to 4 and the 10 kHz switch to V.

iv Vary the 0–100 Hz control for zero beat and note the 0–100 Hz control frequency indication (Example 7.3).

v Set the 10 kHz switch to 7 and the 1 kHz switch to V.

vi Vary the 0–100 Hz control for zero beat indication (Example 3.8).

vii Set the 1 kHz switch to 3 and the 100 Hz switch to V.

viii Vary the 0–100 Hz control for zero beat indication (Example 8.2).

ix Set the 100 Hz switch to 8.

x Vary the 0–100 Hz control for zero beat indication (Example 2.1). The frequency switches and 0–100 Hz control will indicate the measured frequency (152.473821 MHz).

5.3.5 AM Measurement

a. Measure the carrier frequency as described in Paragraph 5.3.4.

b. Set the VERT MODE switch to the VERT SET position.

c. Vary the VERT POS, FOCUS, INTENSITY, HORIZ POS, and HORIZ GAIN controls to produce a trace on the VERTICAL SET line of the CRT graticule and for full-scale deflection in the horizontal axis.

d. Set the VERT MODE switch to the CARR SET position.

e. Vary the CARRIER LEVEL control to position the trace on the CARRIER SET line of the graticule.

f. Set the VERT MODE switch to the 30% AM or 100% AM position as required.

g. Use the LO or HI positions of the SWEEP MODE switch and vary the SWEEP RATE control to synchronize the display. The percentage of modulation will be indicated by the level of the audio peaks on the CRT graticule.

5.3.6 Spectrum Monitor Mode

a. Set the controls and switches as follows:

CARRIER LEVEL	Maximum cw
VERT MODE	VERT SET
SWEEP WIDTH (Δ f)	Maximum cw
AUDIO MODE	BEAT
SWEEP MODE	LO
0–100 Hz	5
AGC/MANUAL	MANUAL
POWER	ON

b. Couple the signal to be measured to the RF INPUT receptacle either directly or by means of the provided antenna.

c. Vary the VERT POS, FOCUS, INTENSITY, HORIZ POS, and HORIZ GAIN controls to produce a trace positioned on the VERTICAL SET line of the CRT graticule and for full-scale deflection in the horizontal axis.

d. Set the VERT MODE switch to the 100% AM position.

e. Set the frequency switches and 0–100 Hz control to the frequency of interest, with the V position selected at the desired decade (Refer to Table 5-2).

f. Set the FUNCTION switch to the "MEASURE 0.06 to 2 mV" position.

g. Vary the SWEEP RATE control as desired (usually just sufficient to eliminate trace flicker, otherwise resolution distortion may occur).

h. The vertical sensitivity of a displayed signal may be varied by means of the FUNCTION switch (0.06 to 2 mV, 2 to 60 μV), the VERT MODE switch (30% AM, 100% AM), and the CARRIER LEVEL control.

i. The horizontal dispersion of the displayed signal may be varied by means of the SWEEP WIDTH (Δ f) control, the HORIZ GAIN control and the decade that is in the V position (Refer to Table 5-2).

j. To determine the exact frequency of a signal of interest on the CRT display, vary the 0–100 Hz control so that the signal of interest lines up with the center graticule line. Set the SWEEP RATE control to the minimum sweep rate. Carefully tune the 0–100 Hz control for maximum amplitude display. The frequency switches and 0–100 Hz control will indicate the center frequency.

NOTE

An alternate method for determining the exact frequency of a signal of interest (if amplitude modulated) is to set the AUDIO MODE switch to the DEMOD position (vary the VOLUME control as necessary) and carefully tune the 0–100 Hz control for maximum sound level from the speaker. The frequency switches and 0–100 Hz control will indicate the center frequency (carrier frequency).

5.4 GENERAL PURPOSE OSCILLOSCOPE FUNCTIONS

NOTE

The frequency response of the vertical amplifier is dc to >30 kHz.

5.4.1 General Purpose Oscilloscope Using Internal Horizontal Sweep

a. Set the controls and switches as follows:

SWEEP WIDTH (Δ f)	OFF
AGC/MANUAL	MANUAL
VERT MODE	EXT
SWEEP MODE	LO or HI as required
POWER	ON

b. Connect the signal to be displayed to the VERT INPUT receptacle (300 mV p-p ±10% for full-scale deflection).

c. Vary the FOCUS and INTENSITY controls for sharpest trace at the desired intensity.

d. Vary the VERT POSITION and EXT VERT GAIN controls for the desired trace position and amplitude.

Table 5-3. Conversion from dBm to Volts for a 50 ohm System

-dBm	Volts	-dBm	Volts	-dBm	Volts
0	224 mV	37	3.16 mV	74	44.7 μV
1	200	38	2.82	75	39.8
2	178	39	2.51	76	35.5
3	159	40	2.24	77	31.6
4	141	41	2.00	78	28.2
5	126	42	1.78	79	25.1
6	112	43	1.59	80	22.4
7	100	44	1.41	81	20.0
8	89.1	45	1.26	82	17.8
9	79.8	46	1.12	83	15.9
10	70.8	47	1.00	84	14.1
11	63.1	48	891 μV	85	12.6
12	56.2	49	798	86	11.2
13	50.1	50	708	87	10.0
14	44.7	51	631	88	8.91
15	39.8	52	562	89	7.98
16	35.5	53	501	90	7.08
17	31.6	54	447	91	6.31
18	28.2	55	398	92	5.62
19	25.1	56	355	93	5.01
20	22.4	57	316	94	4.47
21	20.0	58	282	95	3.98
22	17.8	59	251	96	3.55
23	15.9	60	224	97	3.16
24	14.1	61	200	98	2.82
25	12.6	62	178	99	2.51
26	11.2	63	159	100	2.24
27	10.0	64	141	101	2.00
28	8.91	65	126	102	1.78
29	7.98	66	112	103	1.59
30	7.08	67	100	104	1.41
31	6.31	68	89.1	105	1.26
32	5.62	69	79.8	106	1.12
33	5.01	70	70.8	107	1.00
34	4.47	71	63.1	108	0.891
35	3.98	72	56.2	109	0.798
36	3.55	73	50.1	110	0.708

e. Vary the HORIZ POS and HORIZ GAIN controls for a centered display of desired width.

f. Vary the SWEEP MODE switch (LO or HI) and the SWEEP RATE control for the number of stationary cycles to be displayed.

5.4.2 General Purpose Oscilloscope Using External Horizontal Signals

a. Set the controls and switches as in Paragraph 5.4.1 except that set the SWEEP MODE switch to the EXT position.

b. Connect the external horizontal signal to the HORIZ INPUT receptacle (sensitivity is 500 mV p-p minimum per inch of deflection).

c. Proceed as in Paragraph 5.4.1, varying the external signal frequency as required in Step f.

CAUTION

As with all oscilloscopes, permanent damage to the phosphor coating on the CRT screen may result if the trace is reduced to a spot for an excessive amount of time.

Section VI

APPLICATION NOTES

6.1 FREQUENCY ACCURACY VERIFICATION

The frequency accuracy of Model CSM-1 may be verified in the GENERATE mode using a highly accurate counter connected to the RF OUTPUT as described in the Maintenance Manual, Minimum Performance Test Procedure.

Alternatively, if a suitable standard frequency signal is available, the frequency accuracy of the Model CSM-1 may be verified by using it in the MEASURE mode to measure the frequency of the standard signal and noting the indicated error.

With either method, to minimize uncertainty, the standard frequency should have an accuracy at least 10 and preferably 100 times greater than the accuracy required of the Model CSM-1, which is specified at 1×10^{-6} (Refer to Table 2-2). Thus, the standard frequency should have an accuracy of 1×10^{-7} or better.

Highly accurate standard signals are broadcast continuously by National Bureau of Standards station WWV in Fort Collins, Colorado (as well as WWVH in Hawaii) at frequencies of 2.5, 5, 10, 15, 20 and 25 MHz. These frequencies, derived from cesium-controlled oscillators, are accurate within 1×10^{-11} as transmitted, and even under unfavorable conditions, can be assumed to be much better than 1×10^{-8} as received. Reception should be checked at the various frequencies using suitable attennae, with Model CSM-1 set up to measure frequency as described in Section V (Paragraphs 5.3.1 thru 5.3.4). Reception at 2.5 or 5.0 MHz is generally preferable for stability and convenience of error indication.

Verification Procedure

Once the error frequency has been noted using the normal frequency measurement procedure, set the 0-100 Hz control to OUT and set all the decade frequency switches to the nominal standard frequency. This disables the VCO so that accuracy is related directly to the TCXO unit in the CSM-1.

The error frequency is indicated by the beat light pulse rate (and accompanying audible pulses on the speaker).

The maximum acceptable beat note frequency for a given standard frequency and specified instrument accuracy may be calculated as follows: Δf max (error frequency) = standard frequency x accuracy.

Example: for 5 MHz standard frequency and 1×10^{-6} specified accuracy;

$$\Delta f \text{ max} = (5 \times 10^{6}) \times (1 \times 10^{-6}) = 5 \text{ Hz}$$

Similarly at 2.5 MHz Δf max = 2.5 Hz

Error frequencies of 5 Hz and lower may be conveniently timed using a watch with a sweep second hand. Up to about 25 Hz, the BEAT light pulses are distinguishable: at higher frequencies persistance of vision causes the BEAT light to appear on continuously, so the audible beat note on the speaker is used. If it is necessary to determine beat frequencies accurately (especially above 5 Hz where the beats become hard to count visually) a counter or oscilloscope may be connected to the AUDIO OUTPUT receptacle by means of a phone plug to measure the frequency of the beat pulses.

Recalibration

If the measured error frequency is out of specification, refer to the TCXO section of the Maintenance Manual for normal calibration procedure, using a counter with required accuracy and resolution.

Alternatively, the TCXO adjustment may be performed by measuring a standard frequency as in the verification procedure above. However, as with the normal calibration procedure, it should be performed quickly with the instrument stabilized at room temperature (25°C), setting the TCXO to the offset frequency marked on its case, to ensure compensation over the full specified temperature range (0°C to 50°C). When using the beat frequency to indicate the TCXO offset frequency, there is a possibility of error due to ± ambiguity, therefore, it is necessary to carefully determine the direction of mechanical adjustment in the TCXO versus the direction of frequency change. This should be determined several hours prior to making adjustment so as not to interfere with the stabilization to room temperature or with rapid adjustment after turning the instrument on.

6.2 TECHNIQUES FOR INCREASED FREQUENCY ACCURACY

Model CSM-1 is designed and normally calibrated to maintain its specified accuracy of 1×10^{-6} over the temperature range from 0°C to 50°C. If the Model CSM-1 is to be operated only in a controlled indoor environment, it may be calibrated and maintained at 1×10^{-7}, an order of magnitude higher frequency accuracy, by observing the following special procedures:

a. Before making critical frequency measurements, verifying frequency accuracy or calibrating the TCXO, allow at least 1 hour warm-up time for the instrument to stabilize with the ambient temperature and ac line voltage maintained reasonably constant, preferably 25°C ±3°C and 120 V ±3 V. Avoid unusual heat sources or air currents around the rear panel area (where the TCXO is located).

b. In calibrating the TCXO, rather than following the normal procedure of setting to an offset frequency with no warmup, it is set as close as possible to the exact nominal frequency after warmup as described in a. The counter or standard frequency must be accurate to 1 x 10^{-8} or better.

NOTE

When the Model CSM-1 is specially calibrated in this manner, there is a possibility that it will not meet its normal accuracy specification (1 x 10^{-6}) over its full temperature range from 0° to 50°C. To revert to normal accuracy and temperature range, calibrate the TCXO using the normal procedure described in the Maintenance Manual.

c. When a standard frequency such as WWV is used to verify frequency accuracy or calibrate the TCXO in the measure mode, the 0-100 Hz control should be set to OUT and the frequency switches set to nominal standard frequency (no switch at V) to disable the VCO.

d. When calibrating the TCXO, the beat note frequency Δf must be reduced low enough to ensure the required accuracy. Frequencies below 5 Hz can be measured by counting the number of light pulses occurring over a measured time interval. The maximum beat frequency for a given standard frequency and accuracy is:

Δf max = standard frequency x accuracy.

For an accuracy of 1 x 10^{-7}, Δf max and the corresponding beat rate may be calculated as follows:

Standard Frequency	Δf max	Beat Rate
2.5 MHz	0.25 Hz	15/min
5 MHz	0.5 Hz	30/min
10 MHz	1.0 Hz	10/10 sec
15 MHz	1.5 Hz	15/10 sec
20 MHz	2.0 Hz	20/10 sec
25 MHz	2.5 Hz	25/10 sec

e. When measuring frequency, error frequencies above 5 Hz which are not readily timed with a watch, may be measured accurately with an oscilloscope or counter connected to the AUDIO OUTPUT receptacle (phone plug).

f. Check the frequency accuracy at least twice per month or immediately prior to making critical measurements, calibrating the TCXO as required.

g. If the instrument has been out of service for two weeks or more, it should be operated 24 hours to stabilize before calibrating the TCXO.

6.3 OFF THE AIR MEASUREMENTS

a. When measuring modulation of signals off the air from an external antenna, the operator must keep in mind that the signal reaching the CSM-1 RF INPUT receptacle should not exceed 2 mV rms as indicated by the carrier set response (refer to Section 5.3.1b.). The 20 dB RF attenuator (RFA-20) provided with the accessories may be inserted at the RF INPUT to reduce the input level, should the signal be too strong.

b. When using the rod antenna provided, in the area of a powerful transmitter field, if the RF INPUT signal level is excessive, the rod antenna supplied may be removed and replaced by a much shorter piece of wire and/or the 20 dB pad may be inserted between the rod antenna and the MEASURE INPUT receptacle. In a very strong field it may prove convenient to use only the rod antenna BNC adaptor, with the binding post acting as the pickup element, or even remove the adaptor and allow the open RF INPUT receptacle itself to act as the pickup element.

6.4 CHECKING THE RF OUTPUT LEVEL

The built-in detector at the DET INPUT provides a convenient means to check the presence and normal level appearing at the RF OUTPUT receptacle in both the GENERATE mode and in the MEASURE mode, as follows:

GENERATE Mode:

a. Connect the 3 ft. RF cable from the RF OUTPUT receptacle to the DET INPUT receptacle.

b. Set the CSM-1 controls to generate an unmodulated signal at 9.0 MHz with -4 dBm output level (refer to Section 5.2.1).

c. Set the oscilloscope controls for general purpose according to Section 5.4.1 (VERT MODE-EXT, EXT VERT GAIN-maximum clockwise).

d. Adjust the VERT POS control to place the CRT trace on the VERTICAL SET line on the graticule.

e. Set the VERT MODE switch to DETECTOR. The trace should move upward to the CARRIER SET line (approximately). Rotate the 1 dB step attenuator to the position which places the trace closest to the CARRIER SET line. Normal output level is indicated by a setting between -2 dBm and -6 dBm.

MEASURE Mode:

f. Continuing from step e., set the 1 dB step attenuator to 0.

g. Adjust the EXT VERT GAIN control to place the CRT trace on the 0 (center) line of the graticule.

h. Switch the FUNCTION control to MEASURE (either range). The trace should move upward to the CARRIER SET line on the graticule (approximately) indicating that the ALC loop is functioning properly to increase the synthesizer output by about 6 dB to serve as the measure mixer local oscillator.

6.5 SPURIOUS OUTPUT – EFFECTS ON MEASUREMENTS

Refer to Spectral Purity in Table 2-1. These specifications place maximum limits on undesired outputs at any frequency other than the desired carrier, in terms of decibels below the level of the desired carrier level (dBc). The Model CSM-1 has been specially designed to these stringent specifications to provide excellent spectral purity. However, the operator should be familiar with techniques of recognizing spurious responses, should they occur under unusual conditions, to avoid erroneous interpretation of measurement data.

MEASURE Mode:

Although the measure mode is normally quite free of spurious responses, the possibility does exist, for example, if spurs are excessive from the synthesizer since the synthesizer is used as the high level local oscillator. A measure spur would manifest itself as a weak signal response or a beat note on a desired signal, particularly with the CSM-1 operating near full sensitivity. To verify if such a response is an internally generated spur, the operator should remove the desired signal from the RF input receptacle and observe if the unknown indication remains or disappears. If it disappears, the source of interference is external.

GENERATE Mode:

Using the CSM-1 in the generate mode, the normal applications are measurement of receiver frequency, sensitivity and selectivity, according to the manufacturer's maintenance procedures. The most critical for spurs is the selectivity measurement, since the CSM-1 generator is offset to frequencies outside the receiver passband and the CSM-1 output level must be made quite high to measure, for example, a 50 dB bandwidth. Under these conditions, a spur level of 50 dBc can cause an unwanted response if it falls within the receiver passband, which would have the result of an apparent degradation of receiver selectivity. For this reason the CSM-1 has specified spur suppression of 50 dBc or greater. The same statement applies to far out of band selectivity measurements. If the measurement indicates a spurious receiver response with a level exceeding 50 dBc, it is caused by the receiver. If the level is lower than 50 dBc, it might be caused either by the receiver or by a spurious response of the CSM-1.

Notes

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